InkPhysics

QUESTION WORKBOOK

Comparing electric and gravitational fields

Electric fields · Year 13

AQA 3.7.1, 3.7.3.1 · OCR A 6.2.2(c)

17 questions · 48 marks

PRINT EDITION

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SECTION A · Warm-up

A1 Write down the equation for the gravitational force between two point masses and the equation for the electrostatic force between two point charges. [2]

A2 Write down the equation for the field strength in a radial gravitational field and in the radial electric field of a point charge. [2]

A3 State one fundamental difference between the gravitational force and the electrostatic force between two point objects. [2]

A4 State the SI unit of gravitational field strength and the SI unit of electric field strength. [2]

A5 The ratio of the electrostatic force to the gravitational force between two protons is the same whatever their separation. State why. [1]

SECTION B · Standard

B1 Write down the equation for the potential in a radial gravitational field and in a radial electric field, and state one difference between the two potentials. [3]

B2 Calculate the ratio of the electrostatic force to the gravitational force between a proton and an electron.
$e = 1.60 \times 10^{-19}$ C, $m_p = 1.67 \times 10^{-27}$ kg, $m_e = 9.11 \times 10^{-31}$ kg [3]

B3 The electrostatic force between charged particles is very much stronger than the gravitational force between them. Explain why gravity is nevertheless the dominant force between planets and stars. [3]

B4 State two similarities between gravitational and electric fields. [2]

B5 Near the Earth's surface, $g = 9.81\ \text{N kg}^{-1}$. Calculate the electric field strength that would support an electron against its weight, and comment on your answer.
$e = 1.60 \times 10^{-19}\ \text{C}$, $m_e = 9.11 \times 10^{-31}\ \text{kg}$ [3]

B6 Calculate the gravitational field strength and the electric field strength at a distance of 5.3×10^{-11} m from a proton.
$G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$, $k = 8.99 \times 10^9\ \text{N m}^2\ \text{C}^{-2}$, $m_p = 1.67 \times 10^{-27}\ \text{kg}$, $e = 1.60 \times 10^{-19}\ \text{C}$ [4]

B7 Explain why gravitational potential is always negative, while the electric potential near a proton is positive. [2]

SECTION C · Stretch

C1 Two protons in a nucleus are separated by 1.0×10^{-15} m. Calculate the electrostatic force and the gravitational force between them. [4]

C2 Compare gravitational and electric fields under the following headings: the source of the field, the force law, whether attraction and repulsion occur, and the sign of the potential. [4]

C3 Explain why gravity is noticeable in everyday life while the much stronger electric force between everyday objects is not. [3]

C4 Two identical conducting spheres, each of mass 1.0 kg, have their centres 1.0 m apart. (a) Calculate the gravitational force between them. (b) Determine the charge each sphere would need, equal on both, for the electrostatic repulsion to balance the gravitational attraction, and comment on the size of this charge.
$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}, $k = 8.99 \times 10^9$ N m^2 C^{-2} [5]

C5 A satellite's instruments can be shielded from external electric fields by enclosing them in a metal case. Suggest why nothing can shield them from a gravitational field. [3]